UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 321

OFFICE OF THE SECRETARY

Contribution from the Office of Farm Management, W. J. Spillman, Chief

Washington, D. C. ▼ January 12, 1916

COST OF FENCING FARMS IN THE NORTH CENTRAL STATES

By

H. N. HUMPHREY, Scientific Assistant

CONTENTS

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By H. N. Humphrey, *Scientific Assistant.*

CONTENTS.

The question of fencing was not considered a problem by the pioneer farmer. Timber was abundant and cheap, as was also the necessary labor required to work it up in the form of fences. Land was relatively plentiful and cheap, and it did not matter so much if rail fences and hedgerows did occupy considerable of it. Since pioneer days, however, farming conditions have undergone a radical change. At the same time the mode of fencing farms has undergone an evolution, this evolution at all times keeping pace with the changing farming conditions and adapting itself to them as best it could. Thus has come the transition from early agricultural conditions, with its cheap land, plentiful timber supply, and rail fences, to the farming of the present day, with high land values and a scarce and ever-decreasing supply of timber. The present-day farmer does not have at his disposal an almost unlimited supply of high-grade timber and labor with which to build fences, and he must incur a big outlay of money in securing the necessary materials and labor. To him the matter of fencing his farm suitably and economically has become a problem.

The enormous proportions which the farm-fence problem has assumed to the farmers of the United States can best be shown by the

Note.—This bulletin will be of interest to farmers and students of agricultural conditions in the North Central States.

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use of figures given in the reports of the last census, combined with data obtained in the studies of this office. In 1909 there were 6,361,502 farms in the United States, averaging 138.1 acres each. It has been found that the average 140-acre farm requires 6 rods of fence to the acre, or a total of 828.6 rods to the farm. This would mean that there were in round numbers 5,271,000,000 rods or 16,472,000 miles of fence in use in the United States in 1910. This amount of fence would encircle the earth about 659 times. To replace this with only a medium grade of woven-wire fence, a type which has been very commonly used by American farmers in the past, would cost, at the rate of 65 cents per rod for wire, posts, miscellaneous materials, and labor, $3,426,241,362, which is 8.3 per cent of the total value of all farm property, 12 per cent of the value of all farm land, 54.1 per cent of the value of farm buildings, 69.5 per cent of the value of domestic animals, poultry, and bees on farms, and more than double the value of all implements and machinery on farms, according to the values estimated for these items by the last census. It must be borne in mind, however, that the figures represent the first cost of fences, while the census figures represent the present value of buildings and machinery. Therefore the ratio will not be quite as great.

It may be fairly assumed that the average woven-wire fence, constructed of materials which will permit its erection at a cost not to exceed 65 cents per rod, will not give satisfactory service for more than 15 years. Assuming this to be the case, the renewal cost of farm fences in the United States would amount to $228,416,090 annually. Data obtained by this office show that there is an annual repair charge of 0.024 cent per rod on woven-wire fence. At this rate the repair charges on all fences in the United States will total $126,507,373. The interest on investment at 5 per cent is $171,312,068. Totaling these three items gives an annual upkeep charge of $526,235,531, or a cost of $82.72 per farm, or 59 cents per acre, or 15.37 per cent of the value of the fence as above estimated. There is, of course, a great deal of fencing that is not made of woven wire, but the depreciation, repair, and investment charges on it would be even greater than in the case of woven wire.

The relation of farm fences to the economics of farming has received very little attention in this country—far less than its importance would seem to justify. It was thought, therefore, that a study of farm fences conducted in an area where they were most indispensable might develop some facts that would be of value in establishing economic standards for fencing. It is the purpose of this bulletin to present the essential features of farm-fence practice as found in the North Central States, and to make suggestions to those interested in fence management.

AREAS COVERED BY THE INQUIRY AND FARMING TYPES.

Data were obtained from the 12 North Central States as shown in figure 1.

In Areas 1, 2, and 3 the type of farming followed is the growing of corn, small grain, and forage crops, and the marketing of the greater part of these crops by feeding to live stock on the farm. The stock kept is maintained principally on pastures during the pasture season. Sometimes the pasture field has a regular place in the crop rotation and is changed about from season to season. Another practice is to allow the land to remain in pasture for a long term of years, in some cases indefinitely; the term "permanent pasture" is applied to lands handled in this manner. More fences are required on farms where the pasture forms a part of the rotation than on farms where permanent pastures are used; however, on most farms much of the land is pastured after the crops have been removed, and in some instances the live stock are turned into the field to harvest the crop. It is in these areas where much stock is kept that considerable fence is required to utilize the land to the best advantage.

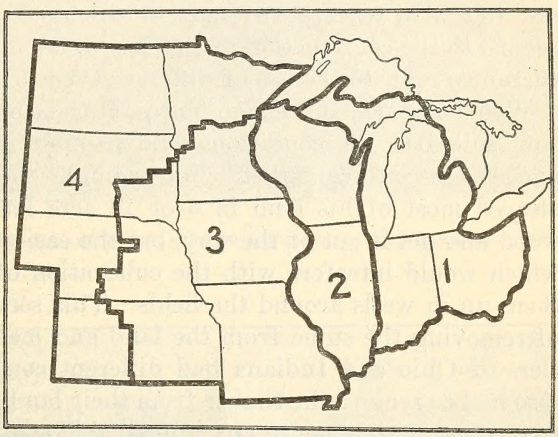

FIG. 1.—The territory covered by the investigation was divided into four areas, as shown here. These areas are referred to by their respective numbers.

Area 4 typifies a country where extensive farming is followed. There are two distinctive types of farming in this area; one is grain growing and the other live-stock farming. The grain farms carry little stock other than the horses required to do the farm work, while on the live-stock farms a relatively small area is in field crops and the stock is carried during the growing season on permanent pastures. Both of these systems require very little farm fence as compared to the fence required on farms in areas where an intensive system of mixed farming is followed.

METHOD OF INVESTIGATION.

The data here presented were obtained by circular letter from farmers in the area designated. The data in the tables were compiled from the reports of 5,837 farmers. Great care was taken not

to include reports which were incomplete, and many such were discarded. It is believed a sufficient number of reports were secured from all parts of the area studied to furnish data which would be representative of the entire area.

LOCAL REQUIREMENTS AND ADAPTATION.

There are four main types of fence in use in this country—wire, wooden, hedge, and stone—but there are almost numberless modifications of these types. Present-day conditions, with high-priced land, scarcity of timber, and the consequent high cost of materials for wooden fences, as well as the higher wages paid to farm labor, have made it impracticable in most localities for the farmer to construct any but wire fence. Any data or discussion in this manuscript in regard to the construction of the most economical kinds of fence will therefore refer to the use of different types of wire fencing.

Wooden, stone, and hedge fences, at the time they were built, were well suited to the conditions, and in most instances they were the logical fences to construct. For example, the New England farmer cleared most of his land in 6 or 10 acre lots. He could burn the wood and get it out of the way, but the easiest way to remove stones which would interfere with the cultivation of the fields was to pile them up in walls around the fields. This served the double purpose of removing the stone from the land and making a fence. The settlers of Ohio and Indiana had different conditions to meet. They also had to remove the timber from their lands, but they did not have to contend with stone to any appreciable extent; so instead of burning all the timber they split some of it up into rails and constructed their fences of them. The farmers who settled in the prairie regions of Illinois, Iowa, Kansas, Nebraska, and other Western States had neither timber nor stone to remove from their farms or to use in the construction of fences. Wire fences at that time were unknown; they naturally planted hedges, which answered both as a fence and as a windbreak.

Stone walls have in many instances become racked, and are hence no longer serviceable. Material for reconstructing rail fences is usually lacking. Hedgerows make very poor fence; they are also expensive. All of these types occupy excessive ground space, form breeding places for weeds and insects, and require much labor to keep them in order. For these reasons the above-mentioned types of fence are gradually disappearing. There are still many stone, wooden, and hedge fences in use, but as fast as they become unserviceable they are being removed and replaced with wire. (Plate I.)

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FIG. 1.—WORM RAIL FENCES ARE RAPIDLY BEING REPLACED BY WOVEN-WIRE FENCES.

FM7024

FIG. 2.—STONE WALLS FORM A HARBOR FOR ANIMALS AND INSECTS AS WELL AS FOR BRUSH AND WEEDS. ON ACCOUNT OF THE LARGE AMOUNT OF LABOR REQUIRED IN THEIR CONSTRUCTION THEY ARE VERY COSTLY.

DISTRIBUTION OF THE VARIOUS TYPES OF FENCE.

The percentage of the different kinds of fence used in the area studied is shown in Table 1.

TABLE 1.—*Percentage of different types of fence used in the various localities studied.*

Area.	Wide woven wire.	Narrow woven wire with barbed wires.	Barbed and smooth wire.	Hedge.	Types of wooden fencing.	Stone fence.
Western Dakota, Nebraska, Kansas, and northern Minnesota	*Per cent.* 5.5	*Per cent.* 10.2	*Per cent.* 84.0	*Per cent.* 0.03	*Per cent.* 0.3	*Per cent.* 0.0
Eastern Dakota, Nebraska, Kansas, and southern Minnesota	8.8	20.0	63.0	6.4	.6	.6
Iowa	8.0	45.5	43.5	2.1	.9	.0
Missouri	13.8	49.4	27.2	5.6	3.8	.04
Wisconsin	13.5	33.4	49.8	.04	2.3	.8
Illinois	11.4	41.7	29.0	12.4	5.5	.0
Michigan	55.9	11.8	11.9	.6	19.7	.0
Indiana	53.3	18.0	12.9	1.6	14.1	.05
Ohio	59.8	3.8	7.0	1.2	27.9	.05

WIRE FENCES.

From Table 1 it may be observed that the greater part of the fencing now in use is constructed of some form of wire. In the western portion of the area studied 84 per cent of the fencing used is made from barbed and smooth wire and 15.7 per cent from the different types of woven wire. In Ohio the opposite is the case, as shown by the fact that only 7 per cent of the farm fences is made from barbed and smooth wire, while 63.6 per cent is constructed from woven wire. It will be noticed that from these two extremes there is a gradual gradation, the amount of woven wire increasing from west to east and the amount of barbed wire decreasing. In this study the woven wire used on farms has been divided into two general classes. Narrow woven wire does not exceed 42 inches in height, with which two or more barbed wires are used to make the fence the desired height. A woven-wire fence over 42 inches high, and which may or may not be supplemented by the use of barbed wire, has been classed as high woven wire. Table 1 shows that the use of the high and the low types is confined to a marked degree to certain well-defined areas. In Ohio, Michigan, and Indiana the greater part of the woven-wire fence used is "wide" (fig. 2), while in the remainder of the area studied most of the woven-wire fence in use is "narrow" (fig. 3). The distribution of barbed and woven wire fencing in the various areas may be explained in part by the requirements of the different kinds of farming followed in the areas.

It is not so easy to account for the use of high woven wire in one area and of low woven wire in another when both follow a very similar

farming system and have the same fencing needs. This may be explained by the fact that Area No. 1 is an older established community than either Areas 3 or 4. Most of Area No. 1 was well fenced with the different types of wooden fence before the days of wire fencing. Farmers here did not, therefore, use much barbed wire, which was the first to be placed on the market. The farms in Areas No. 2 and No. 3 were not as completely fenced at this time, and considerable barbed wire was used in fencing them (fig. 4). Woven-wire fence was developed later, but was placed on the market while the wooden fences in Area No. 1 were yet in use. On account of the high price of the first woven wire, it was made narrow and of

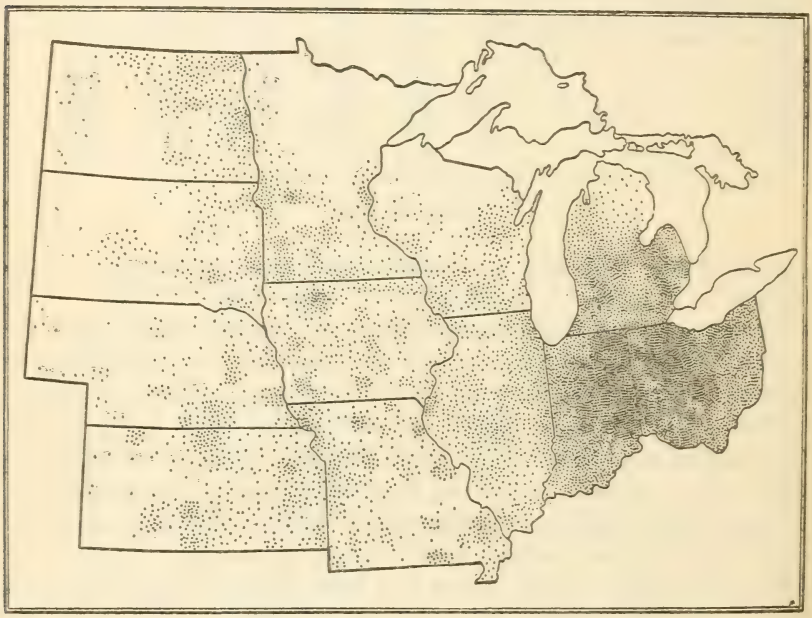

FIG. 2.—The distribution of wide woven wire.

lighter wires to keep down the cost. When the farmers of Area No. 1 began to use much woven wire the processes of manufacture had been so modified that the cost of the wire was much less and the higher fencing was being made.

WOODEN FENCES.

Much wooden fence is still in use in Ohio, Michigan, and Indiana (fig. 5). These States were originally heavily timbered and when the farms were cleared this timber was used to fence them. The best live, white, and bur oak, chestnut, and walnut was used to make rails, boards, and pickets, and the relatively high percentage of wooden fence still in use is the remnant of fences built by the early settlers.

They are not the original fences, however, but are made from the serviceable timber that has survived the numerous rebuildings. Rail fences are blown down by the wind when they are placed in unprotected places and they are sometimes pushed over by stock. They have to be rebuilt on an average of once every 12 to 15 years. Each time they are rebuilt some of the bad rails have to be discarded. The rails now in use are about worn out, and it will be a matter of but a short time when there will be no rail fences in use in these States. Both timber and labor are too expensive at the present time to permit making new rails. Rails that were split from 25 to 40 years ago cost then $1.50 per hundred, and such of them as are still serviceable sell

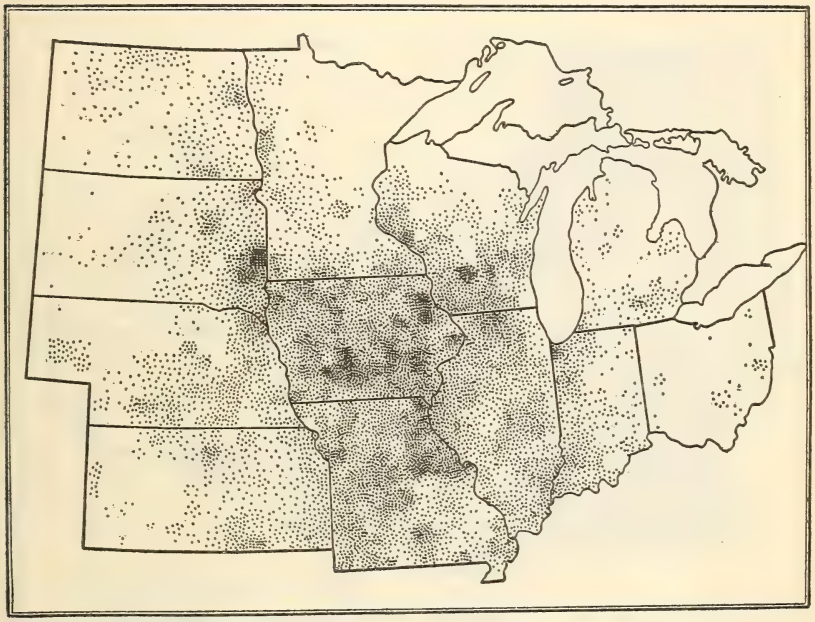

FIG. 3.—The distribution of narrow woven wire.

to-day for from $2 to $3 per hundred. Many old rail fences have brought enough for firewood to replace themselves with good woven wire.

The picket fence is a type which came into use following the worm rail. It made a good fence for all kinds of stock but like other types of wooden fence it has become obsolete with the diminishing timber supply and the introduction of wire fence. The picket fence is very expensive to keep in repair, as the pickets are heavy, especially when wet, and cause the fence to sag.

Board fences still remain in use to a limited extent. They are excellent for some purposes, as the protection of a barnyard from heavy winds. As commonly built, they are comparatively short lived,

and the cost of keeping them in repair is considerable. They are too expensive to be used for field fence.

HEDGE FENCES.

Hedge fences are most extensively used in the prairie regions of central latitudes, but they are scattered in small amounts over a considerable territory, as may be seen in figure 6. Practically all farm hedges in the North Central States are made from the Osage orange, or bois d'arc (wood of the bow). The home of the Osage orange is in Oklahoma and northeastern Texas. It is well adapted to conditions found in eastern Kansas and Nebraska and in southwestern

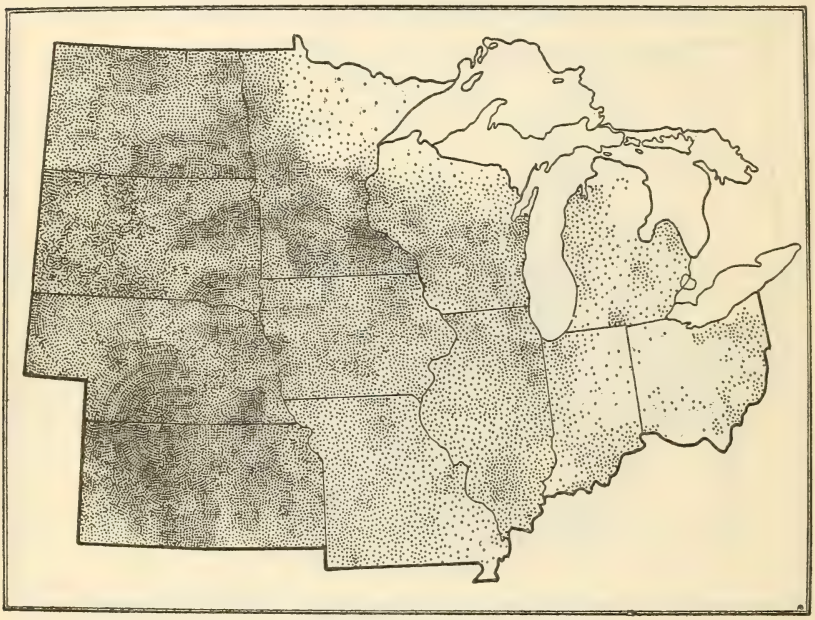

FIG. 4.—The distribution of barbed wire.

Missouri. As previously stated, when hedges were first established in the prairie country they were the most economical fence to be had. Wire fence was not in use at that time; timber was not available except when hauled for long distances, and transportation facilities were poor. Conditions have changed since that time, however, and the hedge fence is no longer desirable or economical. At best, hedge does not make a good fence. If swine are to be fenced, wire must be added in order to make it effective. Hedge plants are often killed by one cause or another and then there is a gap in the fence to be filled if it is to be stock proof. Even if the hedge is kept properly trimmed, it makes considerable land unfit for cultivation, and if it is not kept trimmed the amount of land it wastes increases in pro-

portion to the size of the hedge. The trimming is an expensive operation, and amounts to more than the cost of repair of wire fencing, as will be shown under another heading.

The idea of the hedge fence was brought to this country from England. English farmers were forced to use this means of inclosing their lands on account of the scarcity of timber in that country. This country was settled largely by English people, who clung to the customs of their mother country, and established hedges as a matter of custom, sometimes where the conditions did not warrant their use.

No new hedges are being established in the region here under consideration. Many farmers who have hedges now realize that they

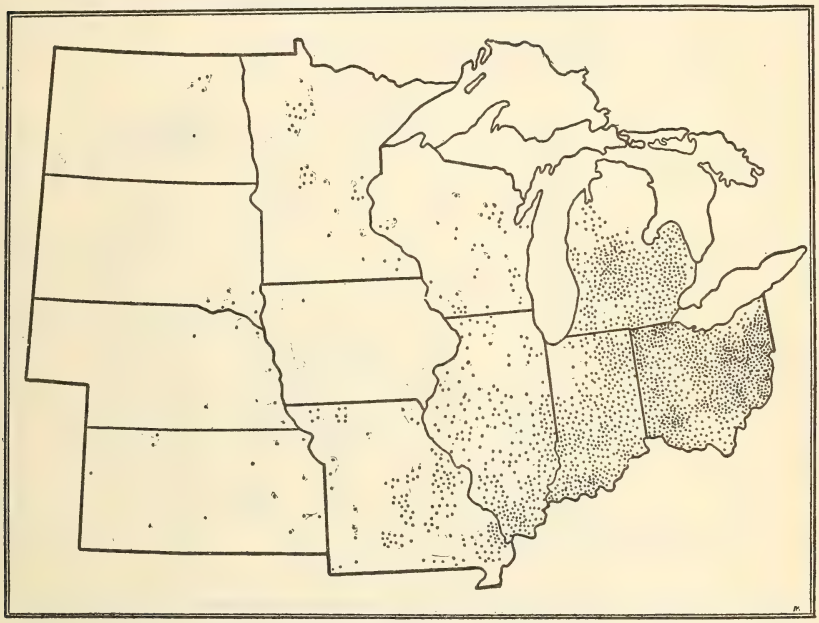

FIG. 5.—The distribution of wooden fence.

are no longer practicable and are removing them from their farms. The only feasible way to get rid of them is to pull them out by the roots. It costs about 30 cents per rod to draw out small hedge by team and from 20 to 25 cents per rod when an engine is used. It will, of course, cost more to remove larger hedge.

STONE FENCES.

There is comparatively little stone fence used on farms in the area studied. In the limestone area of eastern Kansas and in eastern Wisconsin there is some stone fence in use. Small amounts are found in other parts of the area, but not enough to show on the fence map (fig. 7.).

A stone wall when properly constructed makes a very satisfactory fence for all kinds of stock but sheep. They will climb over it unless a rail or wire is run over the top. Stone fences, if not well built with foundations of large stone, will be heaved by frost action. They also form a breeding place for brush and weeds, and harbor insects and burrowing animals. At the present time the labor cost of building a stone fence is so great that its construction is impracticable.

FACTORS INFLUENCING FENCE REQUIREMENTS.

The kind and amount of fence needed on a farm is regulated by the kind of farming practiced and the size of the farm.

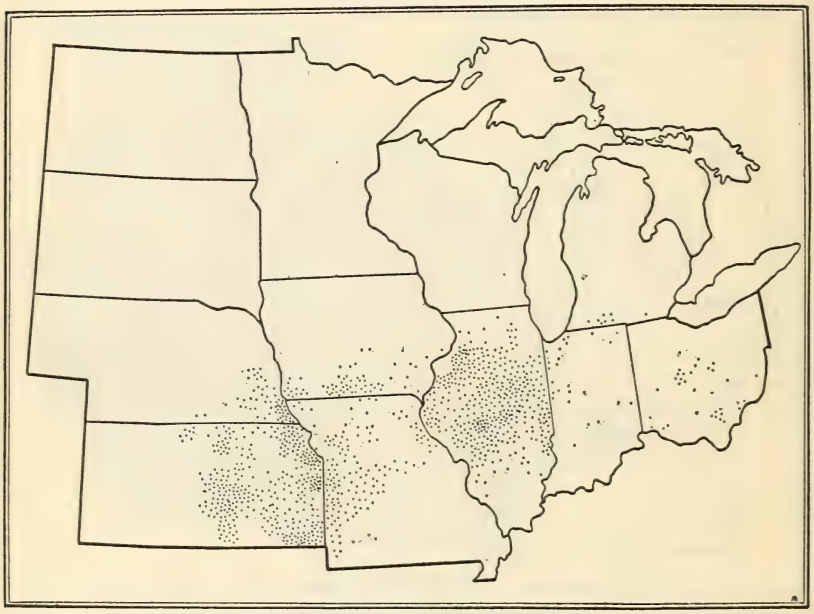

FIG. 6.—The distribution of hedge fence.

Tables 2 to 7 show the distribution of certain types of fencing in the areas where the farming and economic conditions made them the most desirable. The various types of fence do not in all cases best meet the present needs of the localities where they are used. In some instances the farming system has changed, and in others changing economic conditions have made certain kinds of fence obsolete.

A farm fence should combine the two qualities of service and economy. To give satisfactory service it must be constructed so as to turn all kinds of stock, and that without injuring them. To be economical it must be built as cheaply as is consistent with durability.

The fence that is erected at a low initial cost is not necessarily economical, for it may be short lived, which may make it very expensive.

A certain kind of fence may be economical when erected on one type of farm, but it may be very impracticable when used on another farm where conditions are different. For example, a general farm in Ohio and a cattle ranch in western Dakota may be compared. These two types represent widely varying conditions. The Ohio farm averages about 90 acres, of which 70 acres are in crops. Cattle, horses, swine, and sheep are pastured on this farm, and the entire farm is

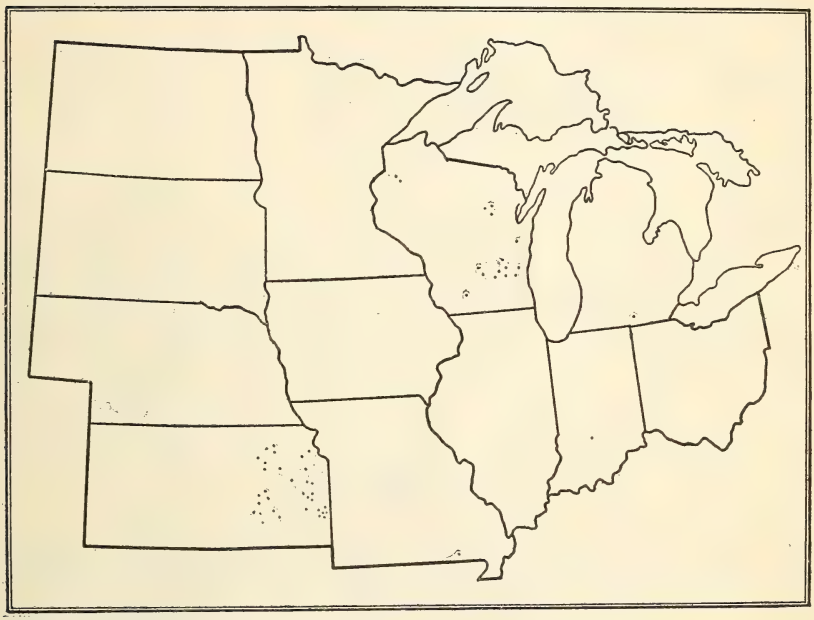

FIG. 7.—The distribution of stone fence.

often pastured at some time during the year. The fence, therefore, must be a general-purpose one and adequate to meet the varying requirements. Woven wire is best suited to such conditions. A barbed-wire fence when constructed so as to be adequate for all kinds of stock requires so many wires that its first cost is nearly equal to that of a good woven-wire fence. The cost of upkeep of a fence of this kind would be much greater than for one of woven wire. In addition, the danger of injury to stock from coming into contact with it is considerable. The farmers in Ohio have realized these things and have mostly abandoned the use of barbed wire.

Conditions in western Dakota are radically different. On the stock ranches here comparatively little land is in crops, while large acreages

are devoted to permanent pasture. The stock kept are mostly cattle, and they are kept on pasture much of the year. Barbed-wire fences sufficient to turn cattle can be much more cheaply constructed than woven-wire fences, and under the conditions prevailing here are nearly as satisfactory. Even if a few steers are lost as a result of wire cuts, their loss would go but a short way toward balancing the higher cost of building and maintaining woven-wire fences.

TABLE 2.—*Number of rods of fence per acre on farms of different sizes in the various areas studied.*

Acreage grouping.	Area No. 1.			Area No. 2.			Area No. 3.			Area No. 4.			Average.		
	Average acreage.	Number of farms reporting.	Rods of fence per acre.	Average acreage.	Number of farms reporting.	Rods of fence per acre.	Average acreage.	Number of farms reporting.	Rods of fence per acre.	Average acreage.	Number of farms reporting.	Rods of fence per acre.	Average acreage.	Number of farms reporting.	Rods per acre.
100 and under ..	77.0	565	8.0	79.3	232	7.4	79.3	51	7.5	.....	....	....	77.8	848	7.8
101 to 140.	123.2	361	6.9	123.8	199	6.3	126.1	67	6.2	.....	....	....	123.7	627	6.6
141 to 180.	160.2	363	6.3	161.1	330	5.7	163.3	346	6.0	160.1	114	4.7	161.4	1,153	5.8
181 to 240.	208.1	272	5.9	214.8	316	5.1	220.1	269	5.3	221.7	26	4.0	214.6	883	5.4
241 to 320.	280.3	167	5.0	289.7	194	4.6	301.2	309	4.8	315.3	131	3.4	296.4	801	4.5
321 to 400.	356.8	93	4.9	366.7	103	4.3	370.5	167	4.7	376.7	39	3.2	366.9	402	4.5
401 to 600.	490.5	76	4.8	480.3	107	4.4	498.8	221	4.2	499.4	108	2.7	493.8	512	4.0
601 to 1,000.	757.0	23	3.6	734.6	45	4.5	743.1	170	3.9	765.9	165	2.4	752.3	403	3.3
1,001 to 1,500.	1,170.6	10	4.5	1,210.8	7	2.8	1,247.4	42	3.5	1,186.6	53	1.9	1,209.6	112	2.8
1,501 and over.....	2,414.2	7	3.1	2,101.6	8	2.1	2,617.8	28	2.5	2,420.6	53	1.7	2,451.1	96	2.1

RELATION OF SIZE OF FARM AND TYPE OF FARMING TO RODS OF FENCE PER ACRE.

From an examination of Table 2 it will be seen that the amount of fence used per acre is considerably less in Area No. 4 than in the other areas. This is due to the fact that much less stock is carried in proportion to the size of the farms by the farms in Area No. 4. There are many purely grain farms in this area which carry no stock other than the necessary number of horses to do the farm work. Some of these farms have a pasture fenced for their horses, and the remainder of the farm is left unfenced.

Table 2 also shows that as the size of the farm increases the number of rods of fence per acre decreases. The smaller fence requirement of the large farm is due first to the fact that less fence per acre is required to inclose a large field than a small one; a square 10-acre field requires 16 rods of fence per acre, while a square field of only 1 acre requires approximately 50 rods; secondly, the crop rotation practiced on the small farm is usually similar to that of the large farm and requires as many fields, therefore proportionately much more division fence than is required by the large farm.

The fence requirement of two farms in the same locality may differ if the cropping systems followed on these farms are not similar. Factors influencing the amount of fence needed by the farm are the number and kind of stock kept, the pasturage customs, and, as already stated, the length of the rotation and the size of the farm. Many farms have fields which are not easily accessible or are too rough for cultivation, and such fields are often kept permanently in pasture. If all the stock on the farm is kept on this permanent pasture during the entire growing season, much less fence is required, there being no division fences necessary between the crop fields. On other farms the pasture forms a unit of the crop rotation, and on many farms having small acreages in permanent pasture it is supplemented by pasture in rotation. Often it is the custom to turn stock into the cultivated fields after the crops have been harvested in order that they may utilize such feed as is left on the ground after harvest. There are very few farms in Areas 1, 2, and 3 on which stock are confined entirely on permanent pastures during the entire pasturage season, and such a practice is not generally feasible. In order to utilize all farm land to its fullest extent in these areas it is necessary for the farm to be suitably fenced.

The field arrangement of the farm is a big factor in influencing the amount of fencing required on the farm. Field arrangement is governed by the natural topographic conditions of the land, the shape of the farm, the roads running through or around it, and the cropping system followed. When the farm is located in a hilly or rolling county it is quite essential that the field arrangement be such as to make it as easy as possible to work over the uneven land. In a level country the question of topography will not have to be considered. The cropping system and the shape of the farm will be considered jointly. The length of the rotation will determine the number of fields on the farm. If a three-year rotation is to be followed, three crop fields will be required; if a five-year rotation is to be practiced, provision will be made for five fields. The arrangement of these fields should conform to the shape of the farm in such a way as to make each field readily accessible to the buildings and to permit the farm work to be done with a minimum of travel. Also the layout of the farm should be such as to make the amount of fence required as small as possible and still retain the other essentials.

In much of the area covered by this investigation the land is divided into sections. Each section is a mile square and contains 640 acres. The highways follow along the section lines, and normally each section is entirely surrounded by roads. A farm must furnish the entire amount of road fence about it, but only half of any fence separating it from another farm. Hence the location of

roads along the farm boundaries will influence the amount of fence needed. Other things being equal, farms having the most frontage on public highways will require the most fence. The number and location of the roads surrounding a farm do much to determine the layout of the farm and consequently the amount of internal fence required. It is the common custom to place the farmstead adjacent to the main or most traveled highway. The field arrangement depends on whether this main road runs along the long side or along the short side of the farm. Many times the farm is cut into two or more separate divisions by roads, but it is more common for it to be in one division. This is especially true of small farms. For purposes of illustration figure 8 shows the field arrangement of two 80-acre farms. Each farm has the same number and the same size of fields, yet B requires 120 rods more fence than A. In B the highway runs along the side of the farm, while in A it runs along the end.

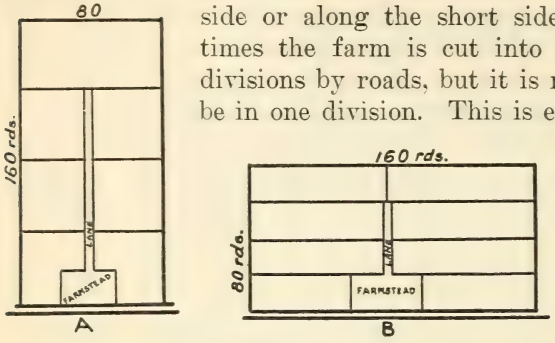

FIG. 8.

The number and cost of farm gates is another item of considerable importance.

TABLE 3.—*Number of gates used on farms of varying sizes in Indiana, Michigan, Wisconsin, and Illinois.*

Acreage grouping.	Average acreage.	Number of farms reporting.	Number of gates.		Rods of fencing per gate.
			Per farm.	Per acre.	
100 and under	78.5	502	9.9	0.126	61.5
101 to 140	124.1	367	12.7	.102	64.6
141 to 180	166.0	512	14.3	.086	67.6
181 to 240	212.3	457	16.6	.078	69.3
241 to 320	286.3	276	19.2	.067	71.7
321 to 400	360.0	137	21.6	.06	75.1
401 to 600	479.4	138	29.2	.061	73.0
601 to 1,000	740.7	50	32.6	.044	110.3
1,001 to 1,500	1,151.3	12	52.9	.046	83.8
1,501 and over	2,047.1	13	40.9	.02	119.1
	Total...	2,464	.....	Average of all..	71.2

The larger farms not only require less fence to the acre but they also require fewer gates for a given amount of fence. There is an average of 1 gate to every 61.5 rods of fence on the smallest farms, as compared with 119.1 on the largest and 71.2 on all farms. The average value of gates is $3.27 each. This makes an average cost of 0.045 cent per rod of fence for gates. The gates used on farms

vary greatly, both as to kind and cost of materials used and the manner of construction. It is not uncommon to find a gate, one that must be opened and closed many times every day, so made that it is a load for the average man to lift, and hung in such a way that every time it is opened and closed the operator has to drag it back and forth by main force. Gates of this kind have no place on any farm. They usually cost just as much as a gate that is so constructed and hung as to be easily handled. There are several types of automatic gates which may be opened and closed by pulling levers so placed that they may be reached by the driver without dismounting from the wagon seat. A gate of this type is very convenient, especially when spirited horses are used on the farm. The arrangement of gates on the farm should be such as to make the fields as readily accessible as possible. In figure 9 is shown a gate arrangement along a farm lane which will allow of the running of stock from one field to another by simply fixing the gates so that they connect the desired fields. The lane is 12 feet wide and the gates 11 feet 9 inches long.

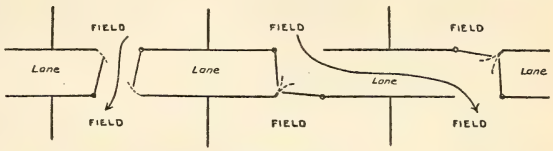

FIG. 9.

TABLE 4.—*Distribution of fence on the farm and how it is effected by the size of farm.*

Kind of fence.	Size of farms (acres).										
	100 and under.	101 to 140.	141 to 180.	181 to 240.	241 to 320.	321 to 400.	401 to 600.	601 to 1,000.	1,001 to 1,500.	1,501 and over.	Average.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Road	24.6	26.2	30.9	30.5	35.3	34.6	34.8	42.0	47.7	43.4	36.3
Line	25.7	26.1	23.2	23.9	22.3	23.4	23.4	20.6	18.0	20.8	22.3
Permanent inside	40.7	40.1	37.8	38.0	35.6	35.9	36.1	32.8	29.3	32.5	35.3
Temporary inside	1.0	1.1	1.5	1.3	1.5	1.0	1.1	.9	1.0	.7	1.2
Farmstead	8.0	6.5	6.4	6.2	5.4	5.1	4.6	3.6	3.9	2.6	4.9

DISTRIBUTION OF FENCE ON THE FARM.

In Table 4 the fences were divided into five general classes with reference to their location on the farm. The names of these classes—namely, road, line, permanent inside, temporary inside, and farmstead—are self-explanatory and denote the location of each on the farm. It may be noted that as the size of farm increases the proportionate amount of road fence increases, while the line or division fence decreases. The amount of permanent inside and farmstead fence is relatively smaller on the larger farms. It will be noticed

that permanent inside fence constitutes on an average 35.3 per cent of the total farm fence, and that there is but 1.2 per cent of temporary inside fence used. In many cases a considerable amount may be saved by the use of temporary instead of permanent interior fences. Figure 10 represents a farm of 160 acres which is fenced on the four sides with permanent fence. The farmstead and the lane are both inclosed by permanent fence. By eliminating the remaining interior fences there are 474 rods less fence to maintain. The annual cost of maintaining 474 rods of a fair grade of woven wire having an investment cost of 65 cents per rod and lasting 15 years is as follows:

Cost of repairs at $0.024 per rod	$11.37
Interest on average investment (total investment $308.10), $154.05, at 5 per cent	7.70
Depreciation, one-fifteenth of $308.10	20.54
Total	39.61

To maintain the necessary amount of temporary fence would require a very small investment. Permanent and solid anchor posts should be placed along the lane and along the outside of the farm at the field divisions. This would require 14 anchor posts, 4 of which could be used in the permanent lane fence. They should not cost over $4 each for material and labor. There would be no depreciation on posts of this kind if they are properly constructed. Enough wire would be needed to fence in any field on the farm. This would require not to exceed 160 rods of fence.

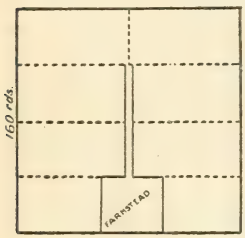

FIG. 10.

If the fence is taken up at the end of the season and stored, it will not be subjected to as much corrosion by weathering, but it would probably become unserviceable as soon as permanent fence on account of being handled and stretched so often. It would probably be more desirable to use medium-weight wire for this purpose on account of the greater difficulty of handling the heavy wire. If heavy anchor posts are provided, it will not be necessary to place the line posts closer than 2 rods apart, as the wire can be stretched very tightly and should not become loose enough in one season to permit stock to get through it. Only a fair grade of posts would be needed to last as long as the wire. Such posts should cost not to exceed 20 cents each, or 10 cents per rod. The largest item of expense would be the labor. This should not exceed 8 cents per rod. A glance at Table 8 (p. 30) would seem to indicate that this figure is liberal. The total approximate cost per rod of materials exclusive of anchor posts would be as follows: Woven wire, 28 cents; posts, 10 cents; barbed wire and staples, 4 cents; total, 42 cents per rod. Following is a summary of the cost of maintaining 160 rods of temporary fencing:

Interest on an investment of $67.20 (average investment $33.60) for fence materials, at 5 per cent	$1.68
Interest on an investment of $56 for anchor posts at 5 per cent	2.80
Depreciation, one-fifteenth of $67.20	4.48
Annual labor charge	12.80
Total annual cost	21.76

There is an annual saving of approximately $18 by the use of temporary fence in this instance. While the practices on some farms may require more interior fencing than the amount cited in this instance, others will not require as much. Many times it will be desirable to pasture two or more fields at one time, and in such a case often only one cross fence will be needed. These figures refer to the construction of a temporary fence which is suitable to all kinds of stock. Often a far less expensive fence would answer the purpose where certain kinds of stock are to be pastured for short periods of time. The farmers in Iowa use a very inexpensive form of fence for hogging down corn. The fence is supported on a row of cornstalks which has had the ears removed and the stalks cut down to the height of the fence. The wire is woven in and out among the stalks so that four hills are on one side and four on the other, and so on. A fence of this kind requires no material for its construction other than the wire and end posts. It can also be quickly built. Besides the direct saving in the cost of maintaining the fences no land is lost to cultivation in the form of headlands along fence rows, and also there is no labor required to keep down weeds and brush that would otherwise accumulate along the fence row.

RELATION OF FIRST COST TO COST OF FENCE MAINTENANCE.

The cost of maintaining a farm fence is determined by five factors: Interest, repairs, and depreciation on the fence itself, interest on the value of the land rendered unusable, and the expense of keeping down weeds. The cost of repairs and the annual depreciation depend largely on the construction. If a fence is made from a cheap grade of material and is cheaply constructed, it will need frequent repair and will be short lived. Such a fence will have both a high repair and a high depreciation charge, which will in most cases more than counterbalance the increased investment cost that the erection of a more substantial fence would require. If a fence is made of good materials and is properly built, its repair and depreciation charges should be very low; but if the increased cost does not represent a corresponding increase in service the investment charge will be so much greater that the decrease in repair and depreciation charges will not counterbalance it.

The efficiency of the fence depends upon the quality of the wire and posts used and upon the manner of construction. Each of these factors will be considered in the order mentioned.

The first step in the construction of a fence is to select the kind best adapted to the purpose for which a fence is needed. The conditions to which the different types of fence are adapted have been briefly discussed under the heading, "Local requirements and adaptation," but it may be well to review and supplement them here. As there stated, barbed wire, when used to inclose extensive pastures and where only cattle are to be restrained, makes a satisfactory fence. Generally speaking, however, its use alone as a fencing material is not desirable. Woven-wire fencing is fast replacing the other types in use on the general farm where several kinds of stock are to be pastured. Fifty-one per cent of the total fencing used in the area covered by this study is woven wire, and the percentage is rapidly increasing. This woven-wire fencing is made up in many different styles as regards height, spacing of the wires, and size of wire. Each style is constructed so as to be adapted to meet certain conditions.

LIFE OF AND TEST FOR WIRE FENCING.

The cost and the life of the various styles of woven-wire fencing differ greatly. Many purchasers consider the first cost of the various kinds to such an extent that they lose sight of the difference in their length of service, which is the controlling factor of their ultimate cost. Table 5 has been computed from the experience of a large number of farmers with the use of the different styles of fencing and shows the relative durability of the different weights and heights of woven wire.

TABLE 5.—*Relative amount of service given by different weights of woven-wire fabric.*

Size of wire.	Number of estimates.	Average life.	Size of wire.	Number of estimates.	Average life.
		Years.			*Years.*
No. 9 throughout	637	21.1	No. 9 top and bottom, No. 11 laterals, No. 12 stays	53	17.7
No. 7 top, No. 9 bottom, laterals and stays No. 11 or No. 12	35	20.3	No. 10 top and bottom, No. 11 laterals and stays	23	16.7
No. 9 top and bottom, No. 10 laterals and stays	73	18.9	No. 11 top and bottom, No. 12 laterals and stays	43	14.6
No. 9 top and bottom, No. 11 laterals and stays	490	17.5	No. 12 top and bottom, No. 14 laterals and stays	46	12.7
No. 9 top and bottom, No. 12 laterals and stays	349	17.4			

Relative amount of service in years given by different widths of woven-wire fabric.

Height of fence, inches	26	32	36	39	42	47	55
Number of estimates	206	214	19	247	42	865	156
Life of wire, years	17.2	17	18.3	18.8	19.9	18.9	21.7

It is becoming generally recognized that the heavier styles of woven-wire fencing are more economical to use. The initial cost of the heavy wire is greater, but it lasts more than enough longer to offset the additional cost. It costs practically as much to con-

struct a fence in which a light grade of woven wire is used as to build one of heavier wire; and as the heavy material lasts much longer the cost of construction is distributed over a longer time, hence it is less per year. During the life of the two types of fence the repair costs of the heavier fencing are less. The percentage of heavy wire manufactured and sold for fencing purposes has greatly increased in the last five years. The use of the wider styles of woven wire has also become more general. The narrower types were first made, as previously mentioned, on account of the excessive cost of materials. It has been the experience of farmers that they are more expensive to maintain, as stock get their heads under the barbed wires and crowd down the woven-wire fence. This is especially true where large hogs come into contact with these fences. Table 5 shows the higher fence has the longer life.

In order to reduce the first cost of a fence, it has been the common practice to buy a woven-wire fabric of smaller-sized wire. By doing this the purchaser is reducing the weight of material, and consequently the initial cost; but in doing it he is practicing false economy. In many cases, however, the first cost of the fence can be materially lessened by eliminating unnecessary material from the fence in the shape of wires that are not needed; for example, when cattle, sheep, or horses are to be fenced against it is not necessary to have a fence with such close spacing as is required when swine are to be turned. The common general-purpose fence in use is one having approximately 10 line wires and a total height of approximately 4 feet; the bottom wires are spaced about 3 inches apart. Such a fence is admirably suited to general purposes where both large and small stock are to be fenced in, but it is not essential to the farmer who keeps either cattle, horses, or sheep, and no swine. A woven fence with fewer wires and wider spacings will serve to turn cattle, horses, and sheep, and such a fence can be erected at considerably less expense, due to the fact that there is less material in it. Woven-wire fencing is made in numerous styles which are adapted to use under widely varying conditions, so it should not be difficult for the farmer to secure a style of fence adapted to his needs.

In the purchase of wire fencing it must be borne in mind that one of the dominant factors controlling the cost of the fencing is the weight of wire in it. This depends on the spacing of the wires and their size. The most accurate means by which the farmer may compare two different lots of wire fencing of the same style is to weigh them. Fencing containing undergauged wire will of course be lighter than fencing which is made from full-gauged wire, provided the spacing of the wires is the same in each case. Wire fencing should be sold by weight rather than by the rod. To a great extent the durability of the fence depends upon the size of wires used in its make-up. The number of wires used will depend upon the purpose for which the fence is to be used.

The chemical and physical properties of the wire and also the amount of galvanizing carried by it are factors in determining its durability. It is not the purpose of this publication to go into the details of the manufacture of the steel, as these are very exhaustively treated in Farmers' Bulletin No. 239 of the United States Department of Agriculture. It may be well, however, to mention the processes commonly used in the manufacture of steel wire. The steel from which most of the wire fencing is made at the present time is manufactured by two processes, the Bessemer and the basic open hearth. Formerly steel for wire was made by what was called the puddled-iron process. This process involved the working of the steel by hand labor, which was necessarily slow and expensive, and upon the introduction of the Bessemer and open-hearth processes it was abandoned, as steel could be made by these processes so much more cheaply. It is generally believed that the steel made from the puddled-iron process was superior to that made by the Bessemer and open-hearth processes for the manufacture of wire fencing. Farmers point to the fact that the first woven-wire fences gave them better service than those of the present day. It is, however, impracticable to make wire from steel manufactured by the puddled-iron process, and the manufacturer of wire fencing of the present day improves his product by increasing the quality and quantity of galvanizing. People have come to realize that the amount of galvanizing carried by the wire greatly affects its life and demand fencing with a heavy coating of it. The relative amount of galvanizing or spelter on a wire may be determined by testing the wire in a solution of copper sulphate.

TEST FOR WIRE FENCING.

The common test applied to determine the relative amount of spelter carried by a woven-wire fabric is as follows: A saturated solution of copper sulphate is made by dissolving 36 parts of copper sulphate to 100 parts of water by weight. Not less than a quart of the solution should be used in the test, and to make a quart of the saturated solution requires approximately 11½ ounces of copper sulphate, or, as it is commonly called, blue vitriol. Slightly more than this amount should be used, however, as there should be a small excess of the copper sulphate. This may be either left in the solution or the solution may be strained off from it. The wire to be tested is immersed in the prepared solution, which should be at a temperature of 60 to 70° F., and left for one minute, at the end of which time it should be removed and wiped thoroughly dry. This operation should be repeated until the wire shows a deposit of metallic copper. The copper will not be deposited on the wire until the galvanizing is removed and a well-galvanized wire should stand at least three immersions in the copper sulphate solution without showing copper deposits on it. Some specially galvanized wire will withstand four immersions without showing copper. This wire is

known as four-minute wire, and may be had at a slight advance in price. When the common commercial copper sulphate is used in performing the test, there is a very slight excess of acid present in the copper sulphate solution which, if not neutralized, may cause the solution to act more strongly on the wire than it should. The acidity may be neutralized by adding a small amount of copper oxide; 2 ounces to a quart of solution should be sufficient. On account of the nonsolubility of the copper oxide it must be added a long time, at least a month, prior to the time the solution is to be used.

POSTS: LIFE, COST, PRESERVATION, AND MATERIALS.

In the construction of a fence the question of the selection of posts is a very important one. The cheapest post to use will vary with the conditions found in the locality where the fence is to be built. The kinds of native timber and their costs must be considered. It is not advisable to construct a permanent wire fence on posts that will not last as long as the wire. When this is done the fence has to be restretched on a new set of posts, the cost of repairs will be considerably increased, and the full efficiency will not be gotten from the wire.

Table 6 shows the average life of the different kinds of fence posts in use in the localities studied, and the cost of these in the different areas. Upon examination of the table it will be noted that the ratio of cost to life is approximately 1 cent per year for most kinds of posts. These figures represent the life of fence posts of approximately 4 inches in diameter, under average conditions. There are many factors influencing the life of a fence post, and these factors have not been considered in this table. The size of posts, the amount of seasoning they receive before being set in the ground, the quality of timber from which they are cut, the kind of soil, the climatic conditions to which they are subjected, and the kind of stock that are to be fenced against, all influence the life of the post. The figures in this table serve to compare one kind of wood with another as to their relative value for fencing purposes. It is shown that Osage orange, locust, red cedar, mulberry, and bur oak are the only kinds of timber that last on an average of more than 15 years when used for fence posts. The supply of practically all of these timbers is limited, and most of them are relatively high priced, especially in areas where they are not native. Osage orange posts are to be obtained commercially in only a small area of the country. This timber is native to northeastern Texas and Oklahoma. There has been much Osage orange hedge built in the past, and many of these hedges have been allowed to grow up into trees and posts have been cut from them. However, this practice is not a profitable one on high-priced land, as the hedge row consumes fertility from too much land which would otherwise go to crop production. The supply of locust timber has been affected by the depredations of the locust borer, and is constantly decreasing, while the price of this timber is increasing. Most of the

red cedar posts which are used in the corn belt area have to be shipped from the Southern States, and their cost to the farmer is steadily advancing. To sum up the fence-post situation, it would seem that the decrease in the supply of timber suitable for use as posts and the increase in cost of this timber to the farmer will in the near future make it advisable to use a substitute for wooden posts or to treat the cheaper woods with a preservative material that will serve to prolong their life.

TABLE 6.—*Average cost by areas and the average life of various kinds of fence posts.*

Kind of post.	Average life.		Average cost in all areas.		Average cost in each area.							
					Area No. 1.		Area No. 2.		Area No. 3.		Area No. 4.	
	Number estimated.	Years.	Number estimated.	Cents.	Number estimated.	Cents.	Number estimated.	Cents.	Number estimated.	Cents.	Number estimated.	Cents.
Osage orange	789	29.9	774	22	105	25	326	24	320	17	23	18
Locust	464	23.8	465	24	501	26	21	22	29	18	14	18
Red cedar	557	20.5	574	29	346	29	97	31	104	27	27	21
Mulberry	88	17.4	82	19	45	20	25	17	12	15	.....	.....
Catalpa	48	15.5	45	17	15	17	17	17	13	18	10	18
Bur oak	97	15.3	90	15	10	16	54	15	26	15	.....	.....
Chestnut	94	14.8	91	15	91	15	.....	.....	.....	.....	.....	.....
White cedar	1,749	14.3	1,709	18	642	18	459	18	374	19	274	16
Walnut	60	11.5	56	13	6	15	11	13	39	12	.....	.....
White oak	1,242	11.4	1,218	12	333	14	389	11	421	12	75	13
Pine	41	11.2	37	18	12	23	7	22	3	11	15	12
Tamarack	67	10.5	64	9	6	16	26	8	7	9	25	9
Cherry	9	10.3	9	8	7	8	2	8	.....	.....	.....	.....
Hemlock	10	9.1	9	12	3	20	6	8	.....	.....	.....	.....
Sassafras	19	8.9	17	14	11	15	6	10	.....	.....	.....	.....
Elm	15	8.8	15	12	6	10	5	9	4	15	.....	.....
Ash	69	8.6	58	10	17	11	2	10	15	10	24	10
Red oak	22	7.0	24	7	6	7	10	8	8	4	.....	.....
Willow	41	6.2	33	7	1	12	2	7	25	7	5	9
Concrete (estimated)	42	48.0	121	30	53	30	48	29	19	31	1	35
Stone	11	36.3	15	35	.....	.....	.....	.....	4	38	11	35
Steel (estimated)	131	29.9	219	30	82	30	71	29	54	30	3	30

PRESERVATION OF FENCE POSTS WITH CREOSOTE.

Decay of wood is brought about by the presence of fungi which live on the tissues of the wood. For the development and growth of these fungi certain conditions are necessary. Their growth requires heat, air, moisture, and a supply of food. It will be noticed that in the rotting of a fence post that part of the post which is at the ground line and just below the surface of the ground is the most affected. This is due to the fact that at this point all conditions are favorable for fungus growth. There is an abundance of air, moisture, and heat. In order to prevent decay it is necessary to remove one or more of the conditions necessary to the fungus growth.

The purpose of treating timber is to remove the conditions favorable to the growth of the fungi which cause decay. The moisture content of the timber may be reduced by placing a waterproof coating over it. Many experiments have been carried on, both by the Forest

Service of the United States Department of Agriculture and by various State experiment stations, with a view to determining the best preservative materials and the effect of the treatment of post timbers with them. It has been found that creosote, a by-product in the manufacture of coal tar, is the cheapest and most efficient preservative, and that naturally short-lived timbers treated with it will withstand decay as long as the most durable woods.

In many localities there is an abundant supply of cheap timber which in its natural state is of little value for fence posts, but which may be treated with a preservative so that its life will be greatly prolonged.

The treatment is very simple, and can easily be done on the farm. The equipment necessary for the work is not expensive, but depends to some extent on the number of posts to be treated and the amount of time available for this work. If it is the intention to treat a few posts at a time, only one tank will be needed.

The posts that are to be treated should be thoroughly seasoned and the bark should be removed from them so that the preservative will be able to penetrate into them. A good time of the year to cut them is in the spring after the buds begin to swell. They will peel very readily at this time, and should season in time for treatment in the late summer or early fall. After the posts are cut and peeled it is well to place them in piles so that the air will circulate through them, but so that they will not season so rapidly as to check.

The method of treatment depends somewhat on the number of posts that are to be treated and the time available for this work. The posts are first placed in a tank of creosote which has been heated to a temperature of about 220° F. They are left in this tank until the creosote has penetrated through the sapwood of the post. The time required to accomplish this depends upon the kind of timber being treated. Soft woods will be more readily penetrated and absorb more creosote. When the post has been in the hot creosote the desired length of time it is then placed in a cold creosote bath, where it should be left for several hours. While in the hot creosote the fibers of the wood expand and force out the air and moisture present. When placed in the cold creosote they contract and form a partial vacuum, thus drawing a quantity of the preservative into the wood cells. If only a limited number of posts are to be treated, or if it is not necessary to complete the work in a short time, the posts may be left in the tank of hot creosote until after it has cooled. If this method is employed, at the most, only two batches may be treated in a day. If many posts are to be treated, it is necessary to have an additional tank for cold creosote. The posts may be taken from the tank of hot creosote and immediately dipped in the cold. This permits a continuous process to be carried on.

The equipment necessary for the first process is a single tank which is large enough in diameter to hold the number of posts it is desired to treat at a time, and it must be high enough to support the posts and to allow the creosote to stand about 6 inches above the mark that will represent the ground line on the post when set. The creosote in the tank may be heated by several different methods—by placing the tank over a fireplace so that a fire may be built directly under it, by attaching a U-shaped pipe to the lower side of the tank so that a fire may be built under the pipe, or by placing steam coils in the tank in such a manner that they will not be in the way of the posts. The cost of the equipment will vary, but should be very small. Maryland Station Bulletin No. 163 estimates that the cost of the double-tank equipment should not exceed $50. It should cost but a small part of this amount to equip a single tank capable of treating two lots of posts each day.

The cost of treatment will vary with the kind of wood used. It has been found that it does not pay to treat a naturally durable wood, because its fibers are so hard to penetrate with the preservative that the operation is a very expensive one, and after treatment a wood of this type is of no more value than a cheaper wood properly treated. Experiments have shown that beech, birch, gums, soft maple, poplar, sycamore, willow, and pin oak respond very readily to treatment. The cost of treating these timbers is approximately 10 cents per post. Creosote may be had in the Central States area for approximately 15 cents per gallon. It may be obtained from hardware dealers.

There is a large area of country, however, where even cheap timber is not to be had. In these localities the fence builder is wholly dependent upon the commercial supply of posts. The increased cost of wooden posts has brought substitutes upon the market in the form of steel and concrete. Posts of these types are coming into extensive use in certain areas and will no doubt be used in far greater numbers in the near future. Table 6 gives the estimated life of both steel and concrete posts, but it must be borne in mind that these figures are only estimates, as neither steel nor concrete posts have been in use long enough to determine their actual life. The estimate of 48 years of life for concrete doubtless does not take into consideration the number of posts that are broken off by accident and otherwise. Whether or not it is advisable to use either wooden, steel, or concrete fence posts will depend to a great extent on local costs of these materials. Until more is known of the service to be had from steel or concrete posts it will not be possible to compare their relative value with the more serviceable types of wood. It may be well to mention a few of the qualities of steel and concrete posts which commend their use.

STEEL POSTS.

Among the qualities possessed by steel posts the one that perhaps appeals to the average fence builder with greatest force is the fact that they are so easily handled, and that fences may be erected in a much shorter time when they are used. Where conditions are right for driving posts, two men should be able to drive 500 steel posts in a day. These posts do not heave, as more bulky ones often do. It is claimed that they form a protection for stock in that they ground currents of electricity carried by the fence during electric storms. For this same reason they should prolong the life of the fence, as the disintegration of wire is partially brought about through electrolytic action. The unfavorable criticism of steel posts is that they are bent by heavy stock rubbing against them. This may be avoided in two ways: First, if the fence is properly constructed, it should be tight enough that when pressure is brought to bear on the fence the strain will be transmitted to the end posts and the intermediate line posts, and thus not brought to bear on any one post alone; second, by the use of heavier posts.

CONCRETE POSTS.

The one point in the concrete post that appeals to the fence builder is its supposed durability. To secure a durable concrete post much care must be exercised in the selection of materials and in the construction of the post. Gravel or crushed rock should be used which does not exceed one-half inch or run under one-fourth inch in diameter. The sand used should be clean and sharp. To secure the best results a very rich mixture must be made and should run 1 part cement, 2 parts sand, and 3 parts gravel. It does not pay to stint the quantity of cement used, for a very slight reduction in cost caused by the use of less cement will make a very big difference in the quality of the post. It is important that the mixing of the materials be done very thoroughly. The reinforcement should be placed near the surface of the post, but not nearer than three-fourths of an inch. There should be enough reinforcing wires so that when a force is applied to the post from any direction at least one wire will be in tension. It has been found that when smooth cold-drawn wire is used for reinforcement purposes, the bond between the wire and the concrete is not strong enough; when a strain is placed on the post such a wire will slip in the concrete. This may be overcome by cleaning the wire with a strong caustic solution and washing with water, or the same result may be gotten by slightly rusting the wires with a diluted solution of sal ammoniac. Homemade wooden forms may be used in the construction of the posts, but better results can be obtained by the use of steel forms. Whether steel or wooden forms are used they should be thoroughly cleaned and oiled before using. The best time to clean the molds is just after the green posts are removed from them and before there is time for particles of concrete

to harden on them. The forms should be oiled before putting in the concrete, so that the surface of the posts when set will have a smooth appearance. A small amount of machine oil applied with a brush will answer the purpose. The concrete should contain enough water so that it may be poured, but not more than this. After being poured into the molds it should be jarred or vibrated so that it will settle and force out any air it may contain. This is essential to the making of a strong, smooth post. Ordinarily the posts can be removed from the mold at the end of 24 hours, but they have to be handled very carefully at this time. They then should be laid on a smooth floor and kept covered for a week or 10 days. During this time they should be sprinkled with water daily to prevent them drying out too rapidly while seasoning. At the end of a week or 10 days they may be stacked on end in piles. They should not be used for at least a month, and it is much better not to use them for three months, as they gain greatly in strength during this time.

In handling a well-seasoned concrete post care must be used not to jar it more than is absolutely necessary. Owing to the excessive weight of concrete posts it is very doubtful if fencing can be erected as quickly with them as with wooden posts. They must also be handled more carefully. They should be well set in the ground to prevent heaving. Should the post heave so as to lean over, its weight will tend to pull the fence down.

Extensive experiments have been carried on at the State college at Ames, Iowa, with the construction of concrete fence posts. In these experiments the cost of the cement used per post varied from 4 to 8 cents, and the cost of reinforcing rods from 9 to 12 cents per post. On farms where sand and gravel are to be had, and where the work may be done at a season of the year when the time might not otherwise be profitably employed, the construction of concrete fence posts is quite feasible. If the work is to be done in winter the concrete must not be allowed to freeze.

CONSTRUCTION OF WIRE FENCES.

The manner in which the fence is erected has much to do with the service to be gotten out of it. No matter how good the wire and posts, if the fence is not properly constructed it will be a very poor one. The cost of erecting a fence is such a small part of the first cost of it that this work should always be well done, yet it is no exaggeration to say that 50 per cent of the wire fences in use are not properly constructed.

The ends and corners are by far the most important elements of a fence. It is absolutely essential that they remain firm and solid in order to hold the fence rigid. In building a fence, therefore, the first thing to consider is the placement of the corner. There are several types of end and corner bracing systems in use any of which if properly installed will hold a fence solid. Plate II illustrates a

few of the more common types in use. Points to be borne in mind when setting wooden end or corner posts are: First, the posts used should be large enough to give sufficient strength. Second, they should be set deep enough not to heave by the action of frost. Wooden end or corner posts should be put into the ground to the depth of 4½ feet, and the brace post should be set 4 feet deep. Third, the brace post should not be set so close to the end post as to require the placing of the brace at an abrupt incline, for this tends to force the end post out of the ground (it is generally considered that 10 feet apart is about the right distance). This arrangement would require a brace 12 feet long, and it is usually inserted in a mortise on the brace post 12 inches from the ground line. The brace should be large enough to remain perfectly rigid.

The manufacturers of steel posts issue instructions regarding the placement of their end and corner posts. These posts are set in concrete, and if properly placed are very solid.

Concrete end and corner posts are made in various styles and shapes. It is essential that they be made of a good grade of concrete and thoroughly reinforced. They may be reinforced with scrap iron, such as wagon tires, axles, etc., and the reinforcement should be placed so that the strain caused from the pull of the fence will bear against it. These posts should be allowed time to season thoroughly before the fence is attached to them.

End, corner, and line posts should be placed so that the ground will have time to settle and harden around them before the fence is strung. It is more essential that the end and corner posts be placed sometime previous to the stringing of the wire. The best time of the year to set posts is in the spring after the frost is out and when the ground is soft. It will thoroughly settle soon after the frost leaves and will leave the posts solid. The wire can then be strung whenever there is time for this work. Whether the posts are set or driven they should be kept in a straight line with the ends of the fence. If there is a curve in the fence the posts may be set so as to make a slight angle, and the post at the apex of the angle should be thoroughly braced in both directions. When steel posts are used they may follow the line of the curve, but in such a case they should be set in concrete and be anchored against the direction of the pull on the fence by using a brace set in concrete, or by the use of a deadman. When the fence is being built over a hilly country, or where there are depressions in the fence row, the posts that are placed in the depressions should be anchored down so that the upward pull of the fence will not tend to draw them out of the ground. This may be accomplished by spiking 2 by 4 crosspieces on the bottoms of the wooden posts before settling them in the ground. If steel posts are used they may be set in concrete.

The distance apart line posts should be set depends on the location of the fence and the number and kinds of stock to be turned. The

average distance in field fence is approximately 20 feet. Around barn lots and pens, where stock are in closer contact with the fence, they are set closer together. Many farmers set posts 1 rod apart. This arrangement is a very handy one in that it furnishes a quick means of measuring portions of a field. It is useful in checking up the amount of work accomplished daily in doing field work. The proper distance to set posts for the greatest efficiency with greatest economy is a matter requiring good judgment on the part of the farmer, for there are many factors involved.

In order to construct woven-wire fencing properly certain tools are necessary. These consist of a woven-wire stretcher, a single-wire stretcher to be used in attaching the fence to the end posts, a pair of wire cutters, a barbed-wire stretcher, a splicing tool, and hammers for stapling and fastening the fence. Some device should be used to unroll the barbed and woven wire. This may be done by attaching the roll of wire to the back of a wagon so that it will unreel as the wagon is drawn ahead, as shown in the illustration (Pl. III, fig. 2), or it can be unreeled by running a bar through the core and drawing it along with a horse. Before the wire is stretched the fence row should be freed from obstructions, and ridges and uneven surfaces should be smoothed off so the fence will be straight on the ground. The wire should be securely attached to one of the end posts and then unreeled. If there is not wire enough in the roll to cover the length of the stretch to be fenced, more may be spliced on to it in the manner shown in Plate III, figure 1.

After the wire is unrolled it should be drawn up to the line of posts and freed from adhering trash. The stretchers are then attached, leaving plenty of chain to draw up the slack in the wire. The stretching should be continued until the line wires are so taut that they can not be pressed together by the hand. If the ground is uneven, the fence should not be stretched so tight that the wire can not be drawn to its proper height on the posts. After the fence is stretched it should be securely fastened to the corner toward which it is being stretched. The next step is to fasten the wire on the line posts. In doing this the line wires should be kept as nearly horizontal as possible. They should not be allowed to follow small irregularities in the ground line and thus zigzag up and down from post to post. The fabric should not be fastened tightly to each post; the staples or ties should permit horizontal movement of the wire. This will allow the weight of the fence to come directly on the corner posts, and will take care of the contraction and expansion of the wire caused by varying weather conditions; also if a blow is delivered against the fence it will not be borne alone by the fabric and posts at the point struck, but the force of it will be distributed along the entire fence line. The barbed wire should be stretched and fastened after the fabric has been fastened in place. It should be placed about 4 inches above

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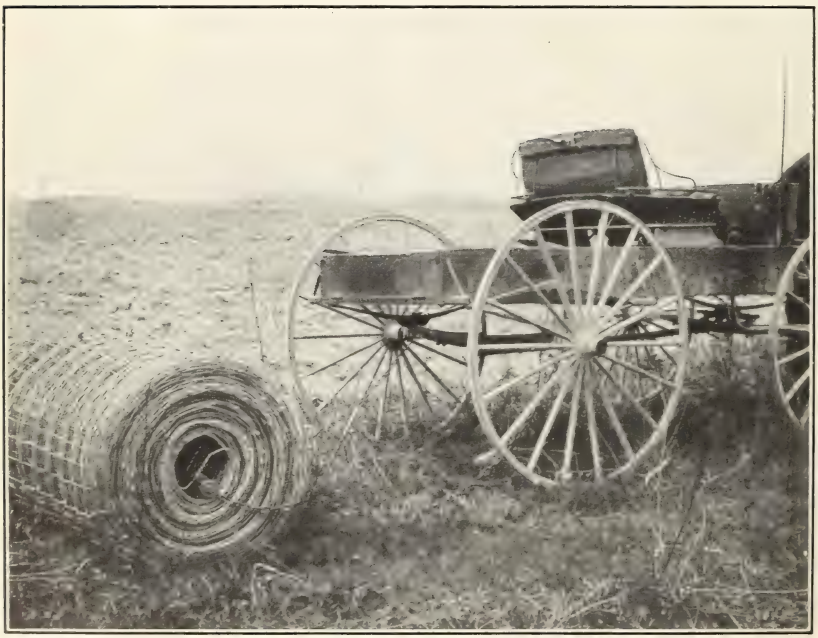
DESIRABLE TYPES OF BRACES FOR ENDS AND CORNERS.

FM7026

FIG. 1.—SPLICING WIRE.



FM7027

FIG. 2.—UNREELING WOVEN WIRE.

FM7025

FIG. 1.—STRETCHING WOVEN WIRE.

FM7030

FIG. 2.—ATTACHING THE WIRE AFTER IT HAS BEEN STRETCHED.

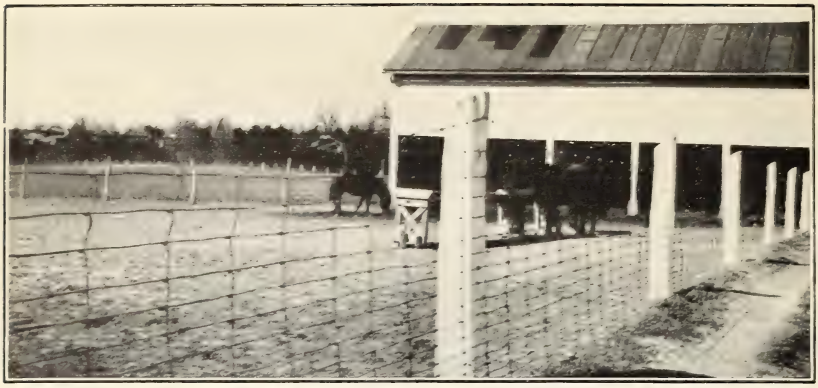


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FIG. 1.—A STRAND OF BARBED WIRE SHOULD BE PLACED ABOVE THE WOVEN FABRIC TO PREVENT HORSES AND CATTLE FROM REACHING OVER AND CROWDING DOWN THE WOVEN WIRE.

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FIG. 2.—TRIMMED HEDGES MAKE UNTILLABLE CONSIDERABLE LAND; UNTRIMMED HEDGE ROWS OFTEN OCCUPY A ROD OF GROUND ON EITHER SIDE OF THEM.

FM6850

FIG. 3.—THE RAIL FENCE OCCUPIES MUCH LAND ON EITHER SIDE OF IT WHICH CAN NOT BE CULTIVATED.

the top of the woven wire so that stock will not be able to get their heads between it and the woven wire. A woven wire fence is not complete without the strand of barbed wire above it; this protects the woven wire by preventing stock from reaching over and crowding it down.

TABLE 7.—*Amount of fence that two men can build in a day, both when setting the posts and when driving them, and when they are spaced at various distances; also the labor cost in cents per rod with wages at $1.50 per day.*

Kind of fence.	Day's work.				Labor cost per rod.				Number of fences on which estimates are based.			
	12 feet or less.[1]	13 to 16½ feet.[1]	17 to 24 feet.[1]	25 to 37 feet.[1]	12 feet or less.[1]	13 to 16½ feet.[1]	17 to 24 feet.[1]	25 to 37 feet.[1]	12 feet or less.[1]	13 to 16½ feet.[1]	17 to 24 feet.[1]	25 to 37 feet.[1]
Barbed wire:												
2 strands—	*Rods.*	*Rods.*	*Rods.*	*Rods.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*				
Posts driven	.....	89.5	95.0	166.9	.....	3.4	3.2	1.8	.....	19	9	11
Posts set	58.7	71.5	75.0	121.5	5.1	4.2	4.0	2.5	8	27	11	30
3 strands—												
Posts driven	64.0	89.1	116.4	156.0	4.7	3.4	2.6	1.9	78	160	42	23
Posts set	43.7	58.7	68.3	95.4	6.9	5.1	4.4	3.1	101	433	136	102
4 strands—												
Posts driven	76.6	83.2	92.4	95.0	3.9	3.6	3.2	3.1	31	66	8	3
Posts set	39.3	47.9	50.6	70.8	7.6	6.3	5.9	4.2	117	315	64	24
5 strands—												
Posts driven	52.2	56.7	70.9	100.0	5.7	5.3	3.8	3.0	16	18	5	1
Posts set	25.3	34.1	38.7	46.2	11.8	8.8	7.7	6.5	33	69	16	4
6 strands—												
Posts driven	29.5	56.7	67.5	.....	10.2	5.3	4.4	.....	10	7	8	.....
Posts set	19.4	26.4	32.0	34.1	15.4	11.3	9.4	8.8	47	128	62	42
Narrow woven wire with 2 or more barbed wires:												
Posts driven	48.7	53.0	74.1	89.8	6.2	5.7	4.0	3.3	122	343	78	48
Posts set	26.3	33.0	37.9	47.1	11.4	9.1	7.9	5.5	440	1,482	535	338
Wide woven wire with 1 barbed wire:												
Posts driven	50.9	55.3	77.2	94.2	5.9	5.4	3.9	3.2	114	329	77	50
Posts set	27.2	33.9	39.9	49.7	11.0	8.8	7.5	4.6	430	1,410	539	332
Wide woven wire without barbed wire:												
Posts driven	61.3	65.4	80.2	108.5	4.9	4.6	3.7	2.8	105	311	52	40
Posts set	30.6	39.0	45.8	56.7	9.8	7.7	6.6	5.3	396	1,270	455	287

[1] Distance apart of posts.

The number of rods of fence that can be constructed in a day varies with soil conditions, the depth to which posts are set or driven, the ability of the men doing the work, the topography of the ground, and the distance apart of corner, end, and gate posts. Table 7 shows the amount of fence that two men can build in a day under average conditions. The posts are set at an average depth of 32 inches and the corner and end posts are placed approximately 40 rods apart. With long, straight stretches of fencing and with other conditions favorable, two men could build more fence than the figures in the table indicate. On the other hand, if the fence is to be constructed over rough and uneven ground and on a soil where it is difficult to set the posts or dig the post holes, or if only short lengths of fencing are to be erected, two men would not be able to build the amount of fence indicated in the tables. The figures indicate the amount of fence that may be erected in a day when the material is on the ground, and do not include the cost of hauling.

COST OF MAINTENANCE OF FARM FENCES.

As stated on a previous page, the cost of maintaining farm fences consists of (1) the interest charge on the money invested, (2) the annual depreciation charges, (3) repairs, (4) interest on the value of the land which is covered by fence rows and from which the farmer derives comparatively little or in some cases no benefit, and (5) the expense of keeping down weeds.

The interest charge is usually reckoned on the prevailing rate of interest on half the cost of a new fence, or it may be reckoned on the average present value of the fences on the farm.

The depreciation charge is determined wholly by the life of the fence. If this is 20 years, the annual depreciation charge would be one-twentieth of the first cost of the fence.

COST OF REPAIRS.

The repair charge will vary with the kind of fences used. The two most important factors influencing them are the quality of the fence and the use to which it is subjected. If the fence is built from good materials and is well constructed, the annual repair bill will be greatly lessened. A fence placed around a stockyard or pasture field will be subjected to harder treatment than one around fields where stock seldom reach it. Also, certain kinds of stock and some individual animals are harder on a fence than others. The repair charges on a fence are light during the early life of the fence, and increase as the fence grows older. There is, however, one item of expense which has to be considered as much with a new as an old fence. This is the cleaning up of the fence row and keeping it free from grass, weeds, and brush. It is estimated that the cost of keeping fence rows free from weeds, etc., amounts to 1 per cent per rod per year.

Table 8 has been computed from a large number of estimates furnished by farmers in the Central States. The figures show that wire fences are by far the cheapest to keep in repair.

TABLE 8.—*Average annual cost of repair per rod for several of the most commonly used fences.*

Kind of fence.	Number of estimates.	Cost of repair per rod.	Kind of fence.	Number of estimates.	Cost of repair per rod.
Woven wire	787	$0.024	Rail	89	$0.045
Barbed wire	290	.025	Picket	17	.047
Board	26	.051	Hedge	1,067	.043

Detailed records covering the cost of repair of woven-wire fence along its right of way for a period of 4 years were furnished by one of the large eastern railroads. These figures, although slightly higher than those in the table, check very closely with them. The annual charge for the upkeep of hedge given in this table covers the cost of trimming the hedge. It has been found by averaging a large number of estimates that when hedge is trimmed once a year a man can trim 30 rods per day; when it is trimmed twice a year a man can trim 70 rods a day; and when it is trimmed three times a year a man can trim 110 rods a day. The cost of keeping the various kinds of wooden fences in repair is very high.

TABLE 9.—*Showing the width of the strip of land (from the center of the fence out on one side) which is made untillable by different types of fence.*

Kind of fence.	Number estimated.	Amount of land made untillable.[1]	Fence required to lose an acre of ground.[1]	Kind of fence.	Number estimated.	Amount of land made untillable.[1]	Fence required to lose an acre of ground.[1]
		Feet.	*Rods.*			*Feet.*	*Rods.*
Woven wire	4,048	3.29	802	Hedge (well trimmed)	2,356	7.6	347
Barbed wire	3,853	3.42	772	Straight rail	2,066	3.57	739
Board	3,000	3.23	817	Worm rail	2,180	6.05	436
Picket	2,683	3.29	802				

[1] Should the fence run between two pasture fields, practically no land would be lost, but when it divides two cultivated fields the width of the strip of land made untillable, as shown by the table, should be doubled and the number of rods of fence required to occupy an acre of ground would be one-half that stated in the table.

When farm land is high priced the amount of land that is covered by fence rows becomes a matter of importance. For this reason worm-rail and hedge fences are not practicable throughout the corn belt, where there are still many of them in use. Table 9 shows the amount of land rendered untillable by different types of fence. They must be doubled if the fence divides two cultivated fields. When a forage or small-grain crop is grown less land is lost along the fence row than when corn, potatoes, or some other cultivated crop is grown, for much land is taken for turning along the fence row with the latter. Local practices also influence the amount of land along the fence row which is not cultivated. Thus, in certain parts of Iowa and adjacent States, it is not uncommon for a farmer to leave a headland 10 to 12 feet in width along his fences; these are used for driveways. In many localities of the East it is the practice to use one horse to plow along the fence row in order to get as close to it as possible.

It will be noted from the table that wire, board, and picket fences take up but a little over 3 feet on a side, while worm-rail fences occupy double this amount of land. The amount of land that the hedge fence renders useless for cultivation will depend upon the size of the hedge. If it is left untrimmed it will sap the fertility of the soil for more than a rod on each side of it; if it is kept well trimmed it occupies nearly double the amount of land taken by a wire fence. If the season is dry, a hedge does much more damage than when there is plenty of rainfall, as its root system extends out to a considerable distance and takes up moisture that is needed by the crops in the adjacent fields.

SUMMARY.

1. The large farm requires proportionately less fence than the small one, and the ratio of fence required to the acre decreases in proportion to the increase in size of farm up to a certain limit.

2. Stone, hedge, and the different types of wooden fences were desirable at the time they were first built, but changing economic conditions make them impracticable at the present time, and they are being replaced with wire fencing.

3. The best kind of wire fencing to erect depends on the purpose for which the fence is used. On a farm where mixed types of live stock are kept, a general-purpose woven-wire fabric is needed. If only cattle and horses are to be pastured, a coarser and less expensive

woven fence can be used. When fencing is needed to inclose extensive pastures where only cattle or horses are to be kept the excessive cost of a woven-wire fence would not make its use desirable, for losses to stock by injury on barbed wire would not be large enough to counterbalance the difference in the cost of maintaining the two different kinds of fences. This applies to the extensive farming areas of the West.

4. It is economy to use a heavy grade of woven-wire fabric. The cost of woven wire is based upon its weight, and a reduction in cost may be obtained by using a style of fencing that has the wires spaced only as close together as is needed to meet the requirements. It is false economy to reduce the first cost of the fence by using a light grade of wire.

5. To get the maximum of service out of a fence it is absolutely necessary that it should be well built. The corner posts must be placed solidly in the ground in such a manner that they can not be heaved by frost or drawn loose by the pull of the fence. The fabric should be strung tightly to the end posts, but it ought not to be tightly stapled to the line posts. It should be fastened to line posts in such manner that the wires may move in a horizontal direction to take care of the contraction and expansion due to changes in temperature, and to distribute the force of a blow along the fence line so that the strain will not come entirely on any one or two posts or any one point of the wire. A barbed wire should be placed a short distance above the top of the woven wire to prevent cattle and horses from crowding it down when reaching over or rubbing against the fence.

6. Cheaply constructed wire fences are expensive to keep in repair. Wooden and hedge fences require a large annual expenditure to keep them in shape.

7. Worm-rail and hedge fences occupy much more ground space than do the other types of fence in use in the area studied. Stone fences also occupy much ground, but very few of them were found in this area.

8. The cost of a good general-purpose farm fence constructed from durable materials will be as follows:

	Per rod.
First cost:	
Line posts; red cedar, hedge, locust, cement, or steel (1 rod apart)	$0.28
Ends and braces; cedar, hedge, locust, cement, or steel (every 40 rods)	.125
Woven wire; 10 strands, 47 inches high, stays 12 inches apart, all No. 9	.40
Barbed wire; 1 strand placed 4 inches above top of the woven wire	.035
Staples	.005
Labor cost of construction	.09
Total	.935
Annual cost of upkeep:	
Repairs, including the cost of keeping the fence row clean	.024
Interest at 5 per cent on average investment ($0.4675)	.023
Depreciation, estimating that the life of the fence is 22 years	.043
Total	.090
Interest on the land occupied at the rate of 5 per cent per year: 108.6 square feet per rod, valued at $125 per acre	.155
Total annual cost	.245

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